ANTERIOR CERVICAL PLATE

FIELD OF THE INVENTION

[0001] This invention relates to an anterior cervical plate, and in particular it relates to such a plate with a new and improved locking element.

BACKGROUND OF THE INVENTION

[0002] It is known to provide an anterior cervical plate for attachment to the anterior of two or more cervical vertebrae for the purpose of immobilizing, stabilizing and/or aligning those vertebrae. The plates can be used for a variety of conditions including for example providing added strength and rigidity after fusion of adjacent vertebrae, securing vertebrae together where an intervening vertebrae has been removed and replaced, correcting spinal deformities, and correcting instability caused by trauma, tumors, advanced degenerative discs, infection or congenital or acquired deformities.

[0003] Cervical plates of the present type are generally elongated so as to span the distance between two, three, four or more vertebrae, as required in a given situation. The plates are generally curved transversely so as to fit the curvature of the vertebrae to which they are attached. Additionally, plates of this type are generally concave longitudinally thereof to match the curvature of the cervical spine. Cervical plates of this type are provided with holes for bone screws. Holes are drilled into the adjacent vertebrae by instruments which are known in the art, after which the cervical plate is attached by bone screws which pass through the holes in the cervical plate for securing the plate to the adjacent vertebrae.

[0004] Many cervical plates of the present type are known, each having various arrangements for securing the bone screws. Such arrangements are shown in prior U.S. Patents Nos. 5,364,399; 5,549,612; 6,193,721; 6,224,602; 6,235,034; 6,383,186; and 6,454,771. Notwithstanding the development of the prior art to date, a need exists for improvements in arrangements for securing the bone screws in place after the bone screws have secured the cervical plate onto the adjacent vertebrae.

SUMMARY OF THE INVENTION

[0005] It is a purpose of the present invention to provide an anterior cervical plate of the type for attachment to cervical vertebrae for stabilizing, immobilizing and/or aligning those vertebrae, which plate has a new and improved arrangement for securing the bone screws in place after the cervical plate has been attached to the cervical vertebrae.

[0006] In accordance with the present invention, the cervical plate includes a number of bone screw holes for attaching the cervical plate to the vertebrae. Specifically, in accordance with the present invention there is provided at least one pair of adjacent bone screw holes, preferably transversely aligned, wherein the cervical plate has a locking element mounted between the adjacent bone screw holes and movable between a first, open position where it uncovers the two bone screw holes to permit insertion therethrough of the bone screws and a second, locking position whereat the locking element overlies at least a portion of each of the two bone screw holes, to lock those bone screws in place. The locking element of the present invention is intended

essentially to prevent the screws from backing out, i.e., it is not intended to be a force exerting member to exert a downward force on tightened bone screws.

[0007] In accordance with one arrangement of the present invention, an elongated locking element is pivotally mounted on a surface area of the cervical plate between two adjacent bone screw holes. This locking element is movable to a first position whereat it completely uncovers the two adjacent holes so as to permit the insertion of bone screws therethrough. The locking element is then arranged to be pivoted to partially cover the two bone screw holes with the bone screws secured in place therebeneath.

[0008] The present invention provides various arrangements for effecting the pivotal connection between the plate and the locking element. In one arrangement the plate may have a raised boss onto which is pivotally mounted a locking element having an opening therethrough. In another arrangement the plate itself can have an opening and the locking element can have a raised boss on the lower side thereof which projects through the through hole in the plate. In another arrangement, the locking element can have a central opening and the plate can have a through hole, both of which cooperate with a third element, a post which passes through the opening and the through hole.

[0009] Another feature of the present invention is the provision of a structure to positively position the locking element in its locking position. For this purpose, a protrusion on either the bottom of the locking element or the surface of the plate can be arranged to be snap fitted into a recess or indentation in the other of the cervical plate or locking element. Preferably, the protrusions will be in the form of bumps on the surface of the plate and the indentions will be in the form of recesses on the bottom of

the locking element, wherein the bumps and recesses are aligned to positively position the locking element when it is in its locking position. The bottom of the locking element may include recessed ramps which ride over the bumps as the locking element is initially turned from its open position to its locking position. The bumps would then ride up the recessed ramps and then snap into place in the recesses when the locking element has reached its locking position.

[0010] Turning of the locking element between its open and locking positions can be accomplished by using a tool, and for this purpose the locking elements are provided with a pair of openings, offset relative to the pivot axis, to receive such a tool.

[0011] The present invention is applicable to cervical plates of a virtually limitless number of configurations. Cervical plates are generally referred to by the number of levels that they overlie, wherein the word "level" refers to the number of intervening intervertebral spaces that are spanned. Thus, for example, a three level cervical plate would span the four vertebrae beyond and between the three intervertebral spaces. The plate can be connected at some places by a single central bone screw through a single central bone screw hole instead of by the two adjacent bone screw holes which include the locking element of the present invention. In virtually all configurations, an opening will be provided between adjacent vertebrae for viewing the intervening intervertebral space.

[0012] In any configuration the cervical plate would almost always be attached to the upper and lower vertebrae. Connections of the cervical plate between the upper and lower vertebrae would depend on the level of the cervical plate and the nature of the surgery performed on the spine adjacent to the cervical plate. For example, if the

surgery involved replacing only the discs and leaving the vertebrae intact in a three or four level cervical plate, then screws might be attached to the intermediate vertebrae. However, a long plate such as a three level or four level plate would more likely be used after a corpectomy, wherein the intervening vertebrae and discs would have been removed and replaced with a bone plug/graft or a mesh/cage implant. In these cases, it is unlikely that screws would be attached between the upper and lower vertebrae, although it might be desirable to place one or two screws into a bone plug/graft.

[0013] Thus, it is an object of the present invention to provide a new and improved anterior cervical plate.

[0014] It is another object of the present invention to provide a new and improved locking element in combination with a cervical plate for locking a pair of bone screws in adjacent bone screw openings of the plate.

[0015] These and other objects of the present invention will be apparent from the detailed description to follow, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] There follows a detailed description of preferred embodiments of the present invention which are to be read together with the drawings wherein:

[0017] Figure 1 is a top plan view of an anterior cervical plate in accordance with the present invention;

[0018] Figure 2 is a bottom plan view of Figure 1;

[0019] Figure 3 is a top plan view of the locking element of Figure 1;

[0020] Figure 4 is a bottom plan view of the locking element of Figure 1;

[0021] Figure 5 is a cross sectional view taken along line 5-5 of Figure 1;

[0022] Figure 6 is a cross sectional view taken along line 6-6 of Figure 1;

[0023] Figure 7 is a cross sectional view taken along line 7-7 of Figure 1;

[0024] Figures 8, 9, 10 and 11 show four different shaped anterior cervical plates, all of which are designed to employ the features of the present invention;

[0025] Figure 12 is a top plan view of an anterior cervical plate showing another embodiment of the present invention;

[0026] Figure 13 is a bottom plan view of Figure 12;

[0027] Figure 14 is a top plan view of the locking element of Figure 12;

[0028] Figure 15 is a bottom plan view of the locking element of Figure 12;

[0029] Figure 16 is a bottom perspective view of the locking element of Figure 12;

[0030] Figure 17 is a view taken along line 18-18 of Figure 12, but showing certain elements in a partially assembled state;

[0031] Figure 18 is a cross sectional view taken along line 18-18 of Figure 12;

[0032] Figure 19 is an exploded view which is taken along a plane represented by plane 18-18 of Figure 12 but showing a modification of the present invention;

[0033] Figure 20 illustrates the embodiment of Figure 19, but during a subsequent state of assembly;

[0034] Figure 21 shows the modification of Figures 19 and 20 in the fully assembled state; and

[0035] Figure 22 is a schematic view showing an anterior cervical plate which would in the final form include the features of the present invention, but showing the plate in relation to vertebrae and discs of the cervical spine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] Referring now to the figures, like elements are represented by like numerals throughout the several views.

[0037] An anterior cervical plate of the type with which the present invention is concerned attaches to the anterior surface of a plurality of cervical vertebrae to perform a number of different functions including stabilizing, aligning and immobilizing two or more adjacent vertebrae. These will be described generally with respect to the diagrammatic view of Figure 22. This figure shows four adjacent vertebrae V1, V2, V3 and V4 separated by intervertebral discs D1, D2 and D3, respectively. Cervical plates are defined by "levels" wherein the term "level" designates the number of intervertebral disc spaces which are traversed by the cervical plate. Thus for example the cervical plate 90 shown in Figure 22 spans three different intervertebral spaces D1, D2 and D3 between vertebral bodies V1, V2, V3 and V4 so that the embodiment shown therein is a three level plate. Cervical plates can come in a longer size, i.e., up to four levels or of course in smaller sizes, i.e., two levels or one level. For convenience, the invention is described throughout the present specification with respect to one level and two level cervical plates. It is to be understood that strictly for purposes of illustration Figure 22 shows the cervical plate 90 against what appears to be an essentially normal spine. In practice, however, as discussed above, when the cervical plate is attached, it will be subsequent to surgery that may have replaced some or all of the intermediary discs and vertebrae with a corpectomy to remove vertebrae which is replaced with a bone graph/plug or a mesh/cage implant or the like.

[0038] A cervical plate can have different openings serving different purposes. In Figure 22 the pair of holes 100 are provided for attaching two bone screws to the upper and lower vertebrae adjacent thereto is the form of bone screw holes to which the locking element of the present invention will be applied. However, in combination with bone screw holes 100, the cervical plate can have other bone screw holes such as simple holes 101 which are shown in Figure 22 for attachment if desired, between the upper and lower bone screw holes 100. Between the attachments to the vertebral bodies the cervical plates are provided with openings 102 which serve as windows to view into the interior of the intervertebral spaces. There will generally be at least one such window opening in the vicinity of each intervertebral space. As is known, anterior cervical plates of this type, in the various configurations, can be used to stabilize, immobilize and/or align the cervical spine following a number of different problems. For example, intermediate disc or discs can be removed and replaced by a cage, mesh or bone graph/plug or allograft/autograft. In addition to removal of the discs, the intermediate vertebrae can also be removed. The cervical plate can also be used to correct instability of the cervical spine caused by trauma, tumors, advanced degenerative discs disease, cervical deformities caused by lordosis or kyphosis or other conditions.

[0039] Figures 1-7 illustrate a first embodiment of the present invention. These figures illustrate an anterior cervical plate 10 which has first, second and third recessed areas 11, 12 and 13 for receiving bone screws through holes 17, 18; 19, 20; and 21, 22, respectively. Between the recessed areas 11, 12 and 13 are provided web areas 15 and 16, respectively, each including a window opening 28 and 29, respectively, for

viewing the intervertebral space adjacent thereto, as described above. In practice, each of the pair of bone screw holes would have a locking element 30 mounted therebetween. For purposes of illustration, in the first embodiment, i.e., Figures 1, 2 and 5-7, the top recessed area 11 includes a locking element 30 in the open position, the bottom recessed area 13 shows a locking element 30 in the locking position and the middle recessed area 12 does not show any locking element, so as to illustrate the recessed area therebelow.

[0040] Referring to Figure 1 and the bottom plan view of Figure 2, the plates include spikes 41, 42 for initially engaging the vertebrae when the cervical plate is first mounted thereon. Some operators prefer to use a fixation pin in addition to the spikes 41, 42, and for this purpose the cervical plate 10 is provided with openings 23 and 24 at the top and bottom thereof, respectively.

[0041] Referring to Figures 1, 6 and 7, the lower bone screw holes 21 and 22 each have a bone screw 35 therein, each having a bone screw socket 36 for receiving a screwdriver for securing the bone screws into the bone. Referring to Figures 6 and 7, in a manner known per se, the screws can be driven into the bone over a range of transverse angles D, as shown in Figure 6, or longitudinal angles C, as shown in Figure 7. Normally the range of the angles C and D is approximately 15°. Referring to Figures 5 and 7, the cervical plates would generally be curved in both the transverse and the longitudinal direction. The radius of curvature of the plate in the transverse direction would be approximately 24 mm, as represented by arrow A, in order to fit the curvature of the vertebral bodies. Referring to Figure 7, the radius of curvature of the

cervical plate in the longitudinal direction would be approximately 200 mm, as represented by arrow B.

[0042] A feature of the present invention is an elongated locking element 30 which is mounted so as to move between an open position as shown at recessed area 11 of Figure 1 and a locking position as shown at the lower recessed area 13 of Figure 1. Referring to Figures 3 and 4, the locking element 30 includes a central hole 31 for engaging the boss 27 on the cervical plate 10 and additional openings 32 and 33 offset from the pivot axis for receiving a tool to assist in turning the locking element 30 between its open and locking positions. To positively position the locking element 30 in its locked position, a pair of bumps 25 and 26 on the cervical plate are positioned to engage recesses 44 and 46, as shown in Figure 4, on the bottom of the locking element 30. To facilitate movement of the locking element over the bumps 25 and 26, the bottom of the locking element 30 includes recessed inclined ramps 45 and 47 which are deep enough to initially ride over the tops of the bumps. The ramps stop short of the recesses 44 and 46 so that as the locking element 30 is turned, the bumps 25, 26 will ride up the ramps and then snap into place in the recesses 44 and 46.

[0043] The embodiment of Figures 1-7 illustrates a first arrangement for attaching the locking element to the boss 27. It is noted that the center boss 27 in recessed area 12 is essentially frustoconical. When it is desired to attach a locking element 30 to a boss 27, the locking element is placed thereon after which the top of the boss 27 is swaged, as shown at 27a in Figures 5, 6 and 7, so as to prevent removal of the locking element while allowing it to pivot thereabout.

[0044] Figures 8, 9, 10 and 11 are intended to show various shapes of anterior cervical plates, each intended for a different level and/or showing a different connection and some such as Figure 9 and Figure 11 showing simple bone screw holes for attachment to certain intervening vertebrae.

[0045] Cervical plate 50 of Figure 8 is a two level cervical plate having pairs of bone screw holes at the two ends thereof which would in practice incorporate the features of the present invention and including a window opening 50a for viewing the intervertebral space therebetween. Figure 9 illustrates another cervical plate 51 which also would include the features of the present invention at the pairs of holes at the top and bottom thereof. This is a two level cervical plate having viewing holes 51a for viewing the intervertebral spaces and a simple central bone screw hole 51b. Figure 10 illustrates a three level cervical plate 52 having the pair of bone screw holes which could receive the locking element of the present invention at all four connections to the vertebrae, and showing window opening 52a for viewing the three intermediate intervertebral spaces. Figure 11 shows a cervical plate 53 which is the same one previously described with respect to Figure 22, and having three viewing windows 53a and two simple bone screw holes 53b.

[0046] Figures 12-18 illustrate another embodiment of the present invention which is identical in all respects to the embodiment of Figures 1-12 with respect to the features of the locking element (and other than the fact that some of the embodiments of Figures 1-12 show different shapes and arrangements of cervical plates), except for a different arrangement for connecting the locking element to the cervical plate.

[0047] For convenience, Figures 12-18 use the same numerals as in Figures 1-7 for identical parts. Different numerals are used with respect to the modified locking element. As seen in Figures 12 and 13, in this case the recessed areas 11, 12 and 13 which receive the locking element include a through hole 65 instead of raised boss 27. The locking element 55, as shown in Figures 14-16, instead of having the opening 31 in the center thereof, has a raised boss 62 on the bottom thereof. This locking element 55 includes tool receiving holes 56 and 57 which are similar to holes 32 and 33 of Figures 1-7. In a manner similar to the embodiment of Figures 1-7, in this locking element 55 there are provided recesses 58 and 60 for cooperating with bumps 25 and 26 and recessed ramps 59 and 61 for riding up over the bumps and allowing the bumps to snap into place into the recesses 58 and 60, precisely as described above with respect to Figures 1-7.

[0048] Referring to Figure 17, the through hole 65 has a chamfer 65a at the bottom thereof. Figure 17 illustrates the locking element 55 with a boss 62 still of the shape as shown in Figures 15 and 16, extending through the opening 65. The assembly process, however, is completed by swaging the lower end of the boss 62 as shown at 62a in Figure 18 to secure the locking element 55 onto the plate 54 while allowing it to pivot relative to the plate 54.

[0049] Figures 19-21 illustrate the anterior cervical plate 54 taken along plane 18-18 of Figure 12 but showing a modified attachment between the locking element and the cervical plate. Referring to Figure 19, the locking element is of the type 30 shown in Figures 1-7 with an opening 31 therein. The plate is of the type 54 shown in Figures 12-17 with a through hole 65 having a chamfer 65a. In this embodiment, a

tapered post 70 is inserted up through the through hole 65 such that its conical surface engages the chamfer 65a with the upper end of post 70 located above the upper surface of locking element 30 as shown in Figure 20. The post 70 is then fixed to the plate at its bottom and swaged at the top as shown at 70a in Figure 21 in order to allow the locking element 30 to pivot relative to the cervical plate 54.

[0050] Although the operation of the present invention will be apparent from the preceding discussion, for convenience the operation will be summarized herein. First, after the problem of the cervical spine has been surgically repaired, the anterior cervical plate is placed against the anterior of the cervical vertebrae. Initially it is held there by the spikes 41, 42 and/or by fixation pins passing through the openings 23, 24. The method of preparing the holes in the vertebral bodies for the bone screws is well known, conventional and need not be further described herein.

[0051] At the recessed areas which include the locking element of the present invention, the screws are tightened to the point where their upper surfaces are at or slightly below the level of the recessed areas so that the locking elements, when pivoted to the locking position, will prevent the screws from backing out but not exert an inward force thereon. The bone screws for the holes adjacent the locking elements are inserted and attached when the locking element 30 or 55 is in the open position as shown at the top of Figures 1 and 12. After the bone screws are tightened in place, a tool (not shown) engages the openings 32 and 33 or 56 and 57 to turn the locking element clockwise. On the bottom of the locking element, ramps 44, 47 or 59, 61 on the bottom of the locking element will ride up the bumps 25, 26 until the locking element moves to its locking position as shown at the bottom recessed area 13 of Figures 1 and

12. At this point the bumps 25 and 26 have snapped into their respective recesses 44 and 46 for locking element 30 and 58 and 60 for locking element 55. A preferred material for the cervical plate would be implantable Titanium alloy, Ti-6 Al-4V per ASTM F-136.

[0052] Although the invention has been described in considerable detail with respect to preferred embodiments, it will be apparent that the invention is capable of numerous modifications and variations, apparent to those skilled in the art, without departing from the spirit and scope of the invention.